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ABSTRACT

The development of motion visual instructional messages should proceed according to systems principles. This would permit the creation of more effective visual messages, allow educators to use more effectively the various media as communication tools, and assist in the refinement of the instructional development process. Like any system, a system for the development of motion visual instructional messages contains inputs, processes, and outputs. Inputs include needs and goals, a mastery model describing the student's role in the setting where he will be expected to use the capabilities he learns from instruction, constraints, and evaluation data. Essential processes which must be found in the system are: content analysis, presentation analysis, scripting, production, and implementation design. The outputs of such a system will be instructional messages which meet the requirements of: 1) integrity (completeness); 2) fidelity (clarity and precision); 3) validity; and 4) reliability. (PB)

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A SYSTEM FOR THE DEVELOPMENT OF MOTION VISUAL INSTRUCTIONAL MESSAGES

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December 1973

Man, a creator of systems, is himself a system. Examples of systems he has created include computer systems, education systems, and mass communication systems. He has found that systems, followed to precision, are effective tools for accomplishing complex tasks. In recent years some scholars have turned their attention to the task of defining instructional systems. Their efforts have revealed that an instructional system requires aural, still visual or motion visual messages which serve as stimuli for the learner. While the general components of instructional systems have been defined, there has been little effort toward systematizing the development of messages used within the instructional system.

The purpose of this paper is to define an instructional message development system which will meet the following criteria: (1) Be supported by basic system's theory; (2) Be an instrument for developing effective instructional messages; (3) Assist in the identification of effective presentation strategies; and (4) Serve as a catalyst for refining the development process.

Systems Theory

Systems have been defined as a group of processes and procedures working together to achieve pre-determined goals. Systems belong to three categories: natural, man-made, and systems which are both natural

and man-made. Included in each category are three types of systems: supra-systems*, systems, and sub-systems (Banathy, 1968). All systems have three components: inputs, processes and outputs (Merrill, 1968).

The viability of systems is determined by their closed or open loop characteristics. These characteristics determine how the system interacts with its environment. A closed system is one that is intra-active, i.e., it interacts with its own components (Banghart, 1969); whereas an open system interacts with its environment. This distinction is clarified by Buckley (1967):

> That a system is open means, not simply that it engages in interchanges with the environment, but that this interchange is an essential factor underlying the system's viability, its reproductive ability or continuity, and its ability to change. . .
>
> The typical response of natural, closed systems to an intrusion of environmental events is a loss of organization, or a change in the direction of dissolution of the system. . . on the other hand, the typical response of open systems to environmental intrusions is elaboration or change of their structure to a higher or more complex level. (p.50)

Many systems have both closed and open characteristics. For example, a typical home furnace has as its inputs -- fuel, power, air, and electrical impulses from a thermostat. The processes of a furnace include a control for turning the fuel on and off, a heat sensor, a power control, and a blower. The output of furnace is warm air. The thermostat makes the furnace an open system. It allows the furnace to interact with its environment -- air temperature. However, what happens if, through some

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* The educational system is an example of a supra-system, which is composed of many systems such as transportation systems, instructional systems, and instructional message development systems.

malfunction, the power control fails to turn on the blower? When the furnace housing reaches a certain temperature the heat sensor will activate the power control and the fuel will be turned off. This represents the closed characteristics of the system.

Instructional systems are more abstract than home heating systems, yet the same basic theory should apply if they are to be viable systems. Stolurow's (1961) adaptive teaching machine system is an example of an instructional system (see Figure 1). The model has an input (Response Unit) and outputs (Knowledge of results and Display) as well as several

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Insert Figure 1 about here

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processes, i.e., those elements enclosed within the box which represent the instructional functions of selecting and arranging stimuli for the learner and evaluating his responses. Merrill's (1968) cybernetic instructional system model contains similar components, but it is more complete since he includes several additional inputs.

These two models have a different conceptual base which accounts for the differences in sequencing the processes. Stolurow was concerned about an instructional system which involved the use of computers for stimuli storage, programing, and response evaluation. Merrill was concerned about a system which would allow the stimuli presentation mode to be modified for different types of learners. Both models have the characteristics of open systems although the cybernetic system seems to be more viable because of the additional inputs.

Instructional Message

Most of the elements found in the models described above received some degree of attention by instructional psychologists and technologists. Perhaps the least attention has been given to the instructional messages which are stored in the library. These messages are one of the key elements to effective instruction, and if they fail to communicate, learning could be adversely affected. This is particularly true if more complex messages such as motion visual messages are used.

The term, instructional message, refers to the content of an instructional product rather than to isolated stimuli. For example, a videotape product is an instructional message, whereas a specific chart within the product is an isolated stimuli. The term is used in order to focus on the content of the product rather than on the vehicles that carry the product. Instructional messages may take the form of aural, still visual (including printed messages), motion visual or some combination of aural and visual stimuli. In order to be effective, instructional messages should meet specified requirements and be developed according to a sound theoretical base.

Requirements:

A system for developing instructional messages should be designed so that the messages produced by the system will meet four requirements -- integrity, fidelity, validity, and reliability.

Integrity. This term refers to the completeness of the message. A high integrity message is one which contains the important rules and concepts included in the content, and all the strategies for converting the rules and concepts into capabilities desired by the learner. Tests

for integrity can be made during all phases of the development process, and in fact, should be applied with equal emphasis to the design, scripting, and production processes since the message can be altered during each process.

Fidelity. A message may have a high degree of integrity and yet be communicated in such a way that content and strategies are obscure and ambiguous. While integrity deals with the completeness of the message, fidelity is concerned with its clarity, precision, detail, and explicitness. The fidelity of the final product is affected by the fidelity of the message at each stage in development. If the fidelity of the message coming out in the design phase is low, then that will affect the fidelity of the scripted message unless additional time is spent by the script writer to clarify the components of the message.

Validity. The meaning of the term validity as applied to the development of instructional messages is similar to the meaning of the term as applied to the development of measurement instrument. Nunally (1967) recognized that the term had some misleading connotations when used in connection with the development of measurement instruments. However, he continued its use since the term had been well ingrained in psychometric literature, and defined validity in a general sense as an unending process of determining if the instrument "does what it is intended to do (p.75)." The same meaning is applied to instructional messages. They are valid if they do what they were designed to do.

Reliability. An instructional message which is able to achieve results when repeated with different members of the target audience is a reliable

product. There is a clear need for research to answer questions concerning the factors that affect the reliability of instructional messages. What strategies are more effective for a particular instructional task? To what extent do technical imperfections in the product affect its reliability? Are some strategies more effective for one medium as opposed to another? These are only a few of the questions that should be investigated if instructional messages are to be made more reliable.

Theoretical Base

Merrill (1971) suggested that an instructional development process have a theoretical base. He identified the following premises to guide instructional development. (Merrill, Endsley, and Asay, 1973)

> Premise No. 1 Objectives must be specified in terms of observable student behavior.
>
> Premise No. 2 Testing instruments should measure the student's ability to perform specified behavior (criterion referenced) rather than how well he performs in comparison with other students (norm referenced).
>
> Premise No. 3 Instructional products must be verified by empirical procedures.
>
> Premise No. 4 Instructional outcomes can be classed into a limited number of behavioral outcomes.
>
> Premise No. 5 Type of task content (concepts and operations) is independent of level of student behavior (discriminated recall, classification, rule using, rule finding).
>
> Premise No. 6 Most courses, particularly at the secondary or higher education levels, involve only four levels of behavior -- discriminated recall, classification, rule using and rule finding.
>
> Premise No. 7 Acquisition of a given kind of behavioral outcome can be optimised by the appropriate manipulation of task variables.

These premises provide a sound basis for the development of instructional messages.

In addition, the author has identified three premises which supplement those provided by Merrill:

> Premise No. 1 The goal of motion visual instructional messages should be to effect some change in behavior on the part of the learner.

Few motion visual instructional messages which may have been produced nationally or locally show evidence that they were designed to produce specific learning outcomes or that there was adequate evaluation to determine if learning occurred. Sesame Street and Electric Company are notable exceptions. Corey (1967) defined instruction as a systematic process of controlling an educational environment in order to obtain desired changes in behavior. This need not be misunderstood as being a process whereby a student is manipulated or coerced to learn. A student is considered a person who has the desire to learn. This is done by controlling the visual and aural stimuli presented to the learner, diagnosing his progress, and helping him plan his learning activities. Media are effective aids in the instructional process, because the production and display of aural and visual stimuli can be controlled.

> Premise No. 2 One contributing factor for the ineffectiveness of mediated instructional messages is communication failure in the development process.

> Premise No. 3 The communicative effectiveness of messages carried by a given medium can be improved when content and presentation strategies are systematically analysed and specified, the production of the messages adheres to the design, and the results of evaluation are impinged upon the development process.

Communication is one of the vital factors of instruction (Gagne, 1970). Assuming that a student is an individual who lacks a desired capability and an instructor is one who assists the student in acquiring that

capability, then instruction is the process of communication whereby the desired capability is learned. When a teacher and student are able to work directly with one another, it is not difficult to achieve effective communication. However, what happens when an instructional medium, like television, is imposed between the teacher and the student? Generally, there are specialists, such as writers and producers, imposed between the teacher and the message. This not only complicates the communication process by adding more steps in the process between the teacher and student, but often further complications arise because development personnel and teachers do not have a common experience background. This difference in "frame of reference" often results in semantic noise which is a communication breakdown due to misunderstanding of the messages being communicated (Emery, Ault, & Agee, 1970). The systematic analysis of content and recording of instructional strategies are important factors in reducing semantic noise in the development process.

Development System

An attempt was made to apply basic systems theory in designing the development model shown in Figure 2. It represents a system which functions

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Insert Figure 2 about here

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within the education supra-system and consists of several subsystems, which will be explained later. The instructional message development system was designed for the purpose of realizing three goals. The first is to create more effective instructional messages. This goal is directed primarily toward motion visual instructional messages where the majority of the

research studies comparing motion visual instructional messages to conventional classroom instruction shows no significant difference between the two (Chu & Shramm, 1968). In most of these investigations the only variable manipulated was the display variable, i.e., television or film presentation compared to live presentation. Had Merrill's Premise No. 7 (Merrill, Endsly, & Asay, 1973) been applied to the motion visual presentation, significant differences may have occurred. It is felt that motion visual messages can communicate more effectively when systematic procedures are applied to their development. This should hold true for other media forms as well.

The second goal, which is closely related to the first, is to learn to use the various media forms more effectively as a communication tool. Many people attempt to communicate through the media using the same principles which are effective in personal communication. This often proves to be ineffective since the characteristics of the media communication system are different than those of the personal communication system. This is especially true for those characteristics associated with feedback. By systematically manipulating presentation or instructional task variables, principles might be found for more effective communication using media.

Refinement of the development process is the third goal. When the message is systematically planned, produced and evaluated according to the plan, not only will more effective messages be produced, but the instructional message development system can be refined.

Inputs

The inputs represent information which is made available to the system.

Inputs to the instructional message development system include needs and goals, mastery model, content, strategies, constraints, data from evaluating the use of the instructional message within the instructional system.

Needs and Goals. The motivation for developing instructional messages should be based on some societal or instructional need and support goals for fulfilling those needs (Merrill, 1973a). The needs may be ascertained by subjective observation or intuitive reflection, however, a more systematic approach such as the problem survey developed by the Evaluation Training Center at Florida State University (Florida State University, 1971) is probably more effective in identifying what Armsey and Dahl (1973) call needs which are "recognized and generally agreed upon (p.101)." Goals, i.e., general statements of intent which are derived from the needs, become the guide for the formulation of the mastery model. Generally the content specialist, working with his colleagues and supervisors, is in the best position to determine the needs and select goals to meet those needs.

Mastery Model: The purpose of instruction is to help the student acquire capabilities that will allow him to function effectively in the real world. The mastery model should be prepared by the content specialist in such a way that it specifies the real world situation and environment in which the student will function. The mastery model is not a behavioral objective, i.e., it does not specify the capabilities the student is to acquire. According to Merrill, Endsley, and Asay (1973), a mastery model should include a statement of who the person is after he has completed the instruction, the setting in which he will perform his activities, the activities he will be performing, and a statement of how well he should

be expected to perform those activities. In other words, it describes the role of the student in the setting where he will be expected to use the capabilities he learns from the instruction.

Content. In order to make an analysis of the content, which is the first phase of the development process, the designer must have access to content sources. These include people, personal observation, printed materials, and existing mediated materials. The content specialist can assist in restricting the scope of the content analysis by eliminating all content that does not fall within the scope of the mastery model. This process tends to expedite the content analysis process.

Strategies. Many types of strategies, i.e., development strategies, instructional strategies, implementation strategies and evaluation strategies, are available for use in the development of instructional messages. For example, instructional strategies, which include strategies for discriminated recall, classification, rule using and rule finding instruction, have become more clearly defined in recent years, especially in the area of concept acquisition (Clark, 1971; Merrill, 1973a). Strategies represent methods, plans or rules for achieving objectives and the designer should become aware of and use them properly in the development process. In many cases the desired strategy will not be available as an input and will need to be devised during the development process.

Constraints. The development of each instructional message is restricted by certain constraints which include target population, budget display devices, production capability, and the characteristics of the instructional system in which the message will be used.

Evaluation Results. This input represents the feedback mechanism which allows the instructional message development system to function as an open system. The evaluation of the message's use in the instructional system should be designed in such a way that meaningful information is obtained concerning the integrity, fidelity, validity, and reliability of the message. Only when this data is impinged upon the development process can there be any hope of systematically realizing the goals stated above, i.e., produce effective instructional messages, learn how to use media for effective communication, refine the development process.

Processes.

Most instructional message development systems contain a production and technical evaluation process. Some include a scripting process. However, to produce instructional messages that will measure up to tests of integrity, fidelity, validity, and reliability, a development system must, at the minimum, have the following processes: content analysis, presentation analysis, scripting, production, implementation design, and a means to bring formative evaluation to bear on the development of the message.

Content Analysis. All content has structure which can be divided into three main elements: identities, concepts and rules. Identities consist of factual information, such as names, dates and places. Concepts are sets of events, objects, things or ideas that have common relevant attributes. A rule is a method or procedure for solving a problem (Merrill and Boutwell, 1973).

Content analysis has been used rather extensively in the development of programed instructional materials where the term "task analysis" was

often applied to the process. The method consisted primarily of observing the task and noting the steps in the procedures. Gagne (1970) suggested a hierarchal task analysis method. This was particularly useful in reading and mathematical tasks where capabilities must be learned in hierarchal order. Some tasks are not so ordered. For these Merrill (1971) suggested the use of the information processing approach to content analysis. Merrill (1973a) has suggested the most powerful content analysis procedure. It is particularly useful for non-task oriented content although it is equally functional for task oriented content. This method allows a more explicit documentation of identities, concepts and rules; and in addition, allows one to show relationships among different content elements.

The purpose of content analysis is to aid the content specialist in identifying the full range of content elements and selecting all the cogent elements for inclusion in the instructional message. Equally important is that when the desired content structure is recorded it becomes a guide for the other development processes and a standard against which the produced message is measured in terms of the requirements discussed earlier.

Regardless of the method used, the content analysis document should contain at least the following information:

1. A concepts and generalities list showing by label each concept, rule, or procedural step; and a definition statement of the label.

2. A graphic plot network showing the relationship of concepts and rules (Merrill, 1973a), or procedural steps (Merrill, 1971).

3. A general verbal description of the plot network.

4. A file of essential examples and non-examples which are representative of the concepts, rules or procedural steps.

The first two steps are not necessarily sequential. It is generally more functional to identify concepts and construct the plot network simultaneously. It has been found that systematic content analysis methods facilitate depth exploration of content, generate insight into the relationships of concepts, and represent a succinct language which expedites communication among all involved in the development process.

Presentation Analysis. The presentation analysis, which specifies how the content is to be taught, is the blueprint for scripting and production and serves as a guide for the implementation design. It also becomes the standard for evaluating the produced product in terms of the message requirements. Methods may vary, but the following information should be specified:

1. The purpose of the instructional message.

2. The constraints which will affect the development and use of the instructional message.

3. Cognitive and affective objectives.

4. Sample test items which will measure achievement of the objectives.

5. A plot of the cognitive strategy.

6. A plot of the affective strategy.

7. A synthesis of the cognitive and affective strategies.

8. A verbal description of the strategy plots.

One of the first steps in a presentation analysis is to specify the purpose of the instructional message. This provides perspective not only for the designer, but for the writing and production teams as well.

For example, the purpose of a certain instructional message might be to teach four concepts and one rule in the area of corporate supervision. This is not an objective, nor a mastery model, but a statement of what the product is intended to do.

Early in the presentation analysis it is important to specify the constraints which will influence the development and use of the instructional message. These may include such things as budget limitations, target population, entry requirements and display facilities. If the constraints are not included, there is a tendency to design, script or produce beyond what the constraints will allow.

Cognitive and affective objectives are drawn from the mastery model and specify what the student should be able to do as a result of the instructional message. Mager's (1962) format, coupled with Gagne's (1971) suggested verb usage*, are helpful in formulating cognitive objectives. Merrill (1973a) suggested cognitive objectives should be limited to four learning tasks -- discriminated recall, classification, rule using and rule finding, and suggested that most instruction be

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*Gagne identified major verbs for six of his levels of learning and suggested that when they were used with minor verbs which tell "how", objectives would become less ambiguous and time consuming to write. For example, an objective for a classification task might be as follows:

> Given unencountered instances of Shakespearian sonnets, the student will identify the relevant attributes by marking the rhyming pattern, meter and quatrains.

In this example, "identify" is the major verb which Gagne suggests be used with all classification tasks and "marking" is the minor verb that tells how the student will identify the attributes.

directed toward assisting the student to acquire classification, rule using or rule finding capabilities.

Affective objectives specify attitudes which the student is expected to acquire. Included in the affective objective would be behaviors which serve as indicators that attitudes are being acquired.

Since objectives specify what capabilities a student should acquire as a result of the instruction, tests should measure his acquisition of those capabilities. If the objective called for the student to acquire a rule capability, the test should ask him to demonstrate the rule. It would not be logical to measure a rule using objective with a classification, or discriminated recall test. This requires the sample test items be provided with the objectives that can serve as a guide for test construction. An additional benefit is that when sample test items are prepared in conjunction with objectives it helps to more clearly define the objectives. At times it may be beneficial to prepare the test items prior to the objectives.

One of the key elements of the presentation analysis is the strategy, i.e. the plan for assisting the student to acquire the capabilities specified by the objectives. If, for example, the objective specifies the acquisition of a classification capability, the cognitive strategy might be to present an expository generality, followed by some expository examples and non-examples, then an inquisitory mode where the student is given practice classifying some unencountered examples. The examples should consist of divergent instances, ranging from easy to hard, accompanied by matched nonexamples (Merrill & Boutwell, 1973).

For discriminated recall, rule using or rule finding objective, the strategy would be modified to include the use of mnemonics, algorithms, and heuristics. Other task variables such as prompts, feedback, the scope of the generalities and examples can be manipulated to provide an optimal learning experiences.

Affective strategies have not been as thoroughly researched as have cognitive strategies. Since the affect deals with emotions and attitude, it is more difficult to measure. However, this should not preclude attempts to identify affective strategy elements and include them in the design. One might begin with attention factors suggested by Hickman (in press) such as vitalness, novelty, suspense and familiarity, or other motivational elements commonly used in rhetoric or sales. By using a systematic process of planning, producing according to the plan and evaluating the results, information can be gathered which will help document affective strategies.

Cognitive and affective strategies can be specified separately then synthesised into a total strategy for the instructional message. The strategies should be written with sufficient detail that the plan will be understood by the other members of the development team.

Scripting. The design documents (content and presention analysis) are highly analytical blueprints. The aesthetic blueprint is in the form of a script which is derived from the design. The scripting process includes preparing a script outline followed by an initial script draft, then revising the script draft until it conforms to the design.

Production. Production procedures will vary depending on the media form that is selected to carry the instructional message. To review them

is beyond the scope of this paper. It is important that content and presentation analyses be understood and followed by those who produce the instructional materials, since strategies can be inadvertently modified during production.

Implementation Design. As a part of the development process, criteria should be specified as to how the instructional message can be most effectively used in the instructional system. The implementation design should also include the objectives, test materials, hardware constraints, personnel requirements for effective implementation in the instructional system, and a description of the type of instructional system for which the product was designed.

SUMMARY

In recent years the systems approach has been applied to most facets of the instructional process. In many cases entire curricula have been modified for the better using system's principles. However, when it has come to the point of developing the motion visual instructional messages to be used in the curriculum, the systems approach has often been thrown aside. When this has happened, the message has become one of the weakest elements in the instructional process. One need not look very far in the area of motion visual messages to discover this fact.

While it is possible to construct elaborate and complex systems for developing instructional messages, the philosophy underlying the system discussed in this paper was to begin with essential elements, then empirically add elements needed to produce a system which will meet the following goals: (1) produce effective instructional messages, (2) learn how to communicate more effectively through the various media, and (3) refine the development process.

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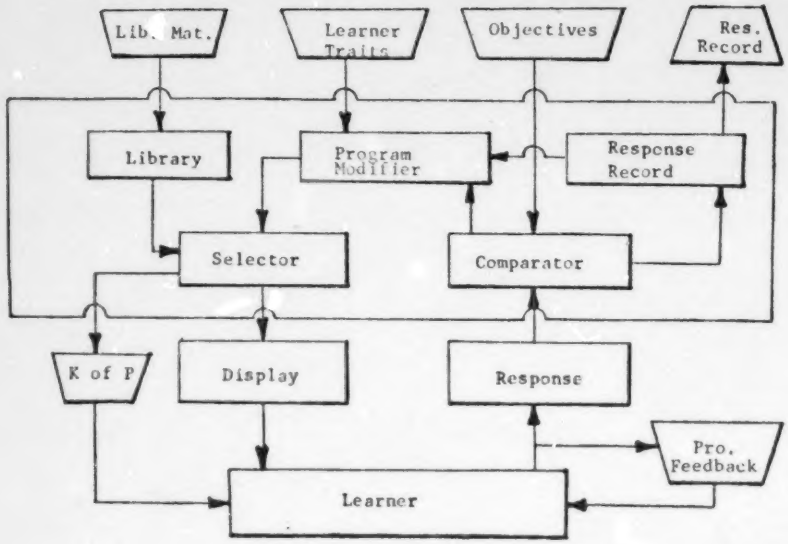
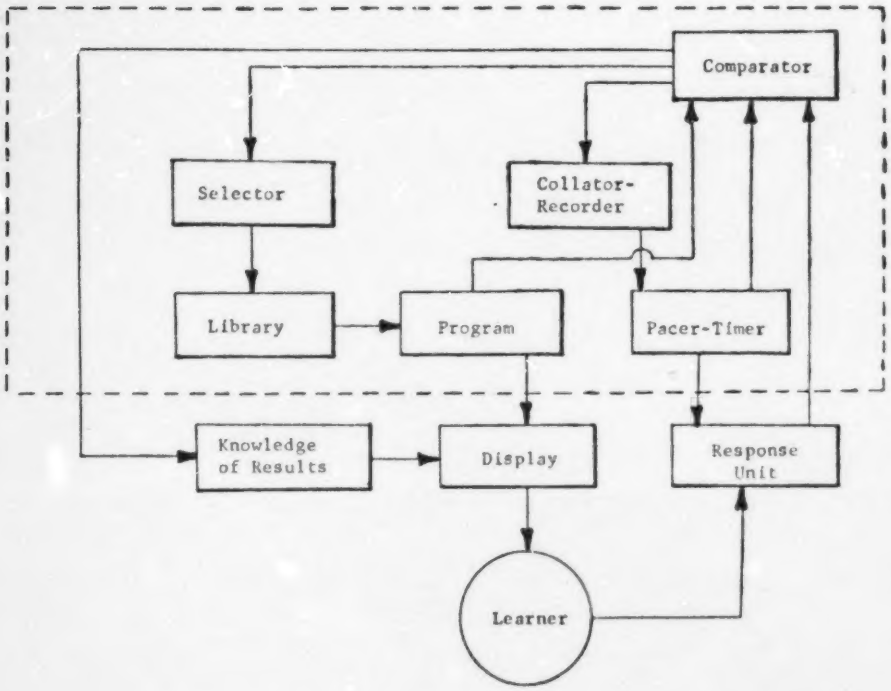


Merrill's

Cybernetic Instructional System



Stolurow's

Adaptive Teaching Machine System

Figure 1

Comparison of Stolurow's and Merrill's Models

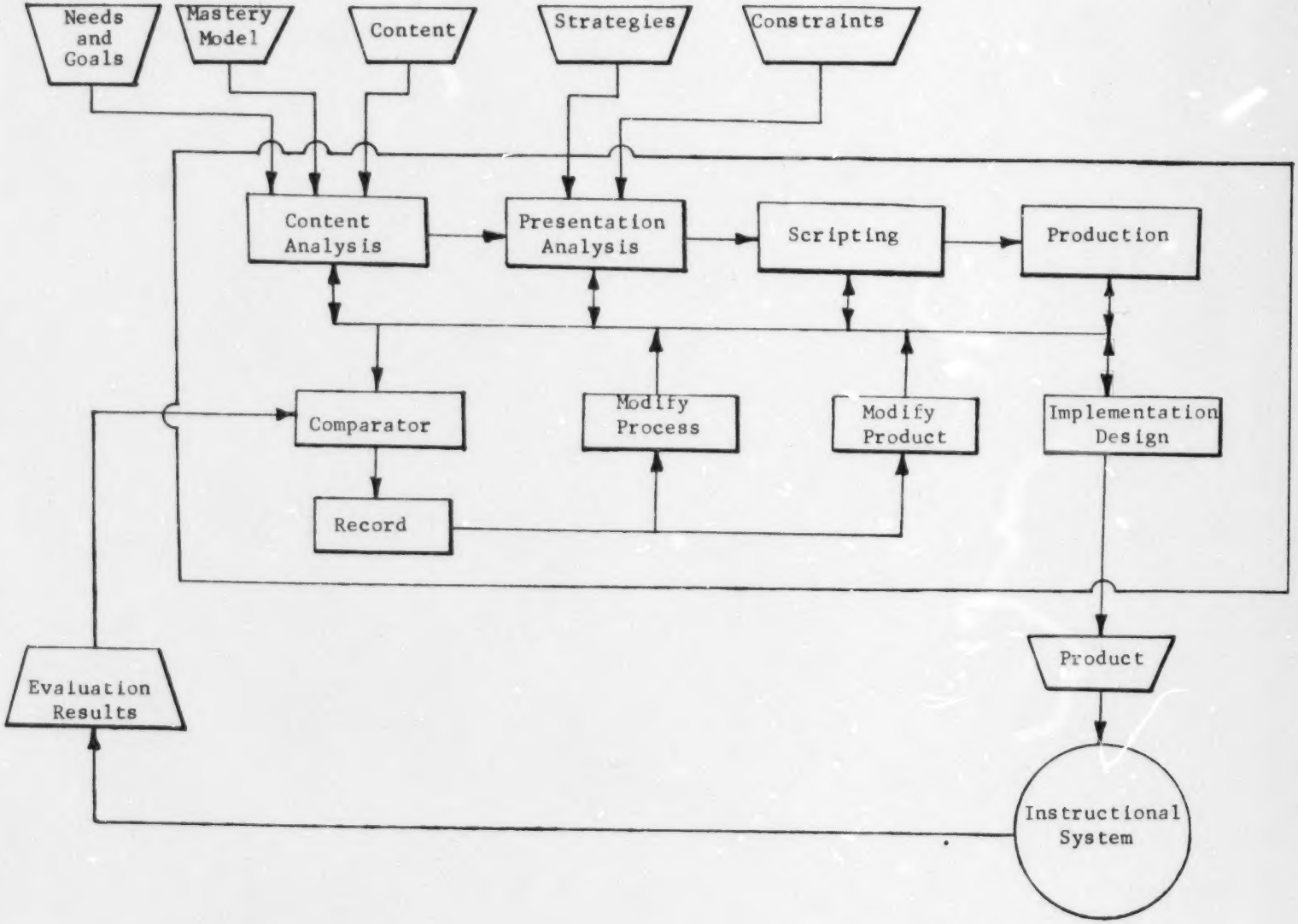


Figure 2

Instructional Message
Development System